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Study of Antibiotic-Resistant Bacteria and Effect of Sepsis in Heart Failure Patients in Karbala

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ABSTRACT

Heart failure (HF) can be defined as a complex clinical syndrome, which might result from any structural or functional heart disorder affecting the ventricular filling or the ejection of blood into systemic circulation. Sepsis represents a potentially fatal organ infection that results from a dysregulated host organ response to infections. Finding the most prevalent bacterial species causing sepsis in HF patients and figuring out their pattern of antibiotic susceptibility in Karbala city were the goals of the presented research. Methods: The research was conducted at the Imam Hussain Medical City Hospital's Heart Center in Karbala between January and August of 2024. Following being admitted to the cardiac care unit, 25 patients with HF and bacterial infection and 25 patients with bacterial blood infections who did not have HF had 10 milliliters of venous blood drawn. Results: After the samples were cultured on different conditions to detect bacteria, antibiotic susceptibility testing was conducted. Were number of Gram negative bacteria =14 and Gram positive bacteria =11 in the group with infection without heart failure, while the number of Gram negative bacteria =16 and Gram positive bacteria =9 in the heart failure group with infection and the most common genius in infection group was Klebsiella pneumoniae which accounted for 8 (16%) isolates While, the most common genius in heart failure with infection group was Staphylococcus hominis which accounted for 5 (10%) isolates, all isolated species were found to be resistant to Ciprofloxacin (80%) in both groups and all isolated species were sensitive to Pefloxacin, Colistin, Ampicillin, Vancomycin, Linezolid and Streptomycin. Conclusion: The study concluded that the most common types of bacteria were *Klebsiella pneumoniae* and *Staphylococcus hominis* in the group of patients with and

without heart failure, and the isolated bacteria were highly resistant to some antibiotics and highly sensitive to others.

Keywords**:** Sepsis, Heart Failure**,** Antibiotics , Resistance, Bacterial infection

1. Introduction

Sepsis can be defined as a potentially fatal organ infection brought on through a dysregulated host organ response to infections. In the case when underlying circulatory, metabolic, as well as cellular abnormalities raise the risk of mortality beyond what sepsis alone could cause, septic shock must be considered a subtype of sepsis [1]. Due to their rising incidence and significant molecular, pathophysiological, genetic, and clinical complexity, septic shock and sepsis represent one of the significant and expanding global burdens as well as a challenge for emergency physicians [2,3]. HF, also known as complex clinical syndrome, could be caused by any functional or structural disorder that impairs ventricular filling or the ejection of blood into ventricular circulation for meeting systemic demands [4]. Over 23 million people worldwide and over 6.2 million in the US suffer from HF; by 2040, that figure is expected to increase to 1.5 million people annually [5]. In the case when sepsis and/or septic shock are present, infections one of the primary causes of HF decompensation-must be detected early and treated in accordance with specific criteria [6]. The discovery of antimicrobials was one of the most significant advancements in public health during the past century. Antibiotics can be described as natural products that are produced by microorganisms or their semi-synthetic counterparts. Since those compounds were in the environment for a very long period, bacteria had to evolve various antibiotic resistance forms in order to survive [7].

Finding the most common species of bacteria that cause sepsis in HF patients and determining their pattern of drug susceptibility were the goals of this work.

2. Materials and Methods

2.1 Ethical Approval

Before the specimen was collected, written permission was obtained from each study participant, and all subjects involved in this experiment were informed. The university of Kerbala ,College of

Education for Pure Science Ethics Committee gave its approval to this work.

2.2 Study Design

A total of 50 samples have been taken from the coronary care unit (CCU) at the Heart Center of Al-Hussein Teaching Hospital in Al-Hussein Medical City/Karbala between January and August of 2024. The study samples were split into two groups: 25 samples from patients with HF who also had sepsis or bacterial infection, and 25 samples from patients who had bacterial infection in their blood but did not have HF.

2.3 Clinical Samples

After being admitted to the cardiac ICU, patients with HF and those with infection but no HF had venous blood samples obtained, totaling around 10 milliliters. [8] collected the required supplies for blood culture, such as blood culture bottles, sterile gloves, a sterile syringe (10 ml), adhesive tape, a dressing, a sterile povidone-iodine pack with cotton swabs and gauze, and a sharps disposal basket. They also followed important blood culture procedures. After choosing an appropriate vein, a povidone-iodine solution was used to swab the puncture site. One to two minutes were given for the antiseptic to dry. After that, a needle has been cautiously put into the vein of the patient. At least 10ml of blood were extracted. Following the disinfection of the top of the blood culture bottle with an alcohol swab, the blood has been placed in a culture bottle. BacT/ALERT® 3D system was after that used in order to send the blood culture bottle to lab for incubation. Following that, bacteria were gathered and put onto mannitol salt agar, MacConkey, and blood agar plates. Those plates have then been incubated at 37ºC with 5% CO2 present [9].

2.4 Questionnaire Sheets

Questionnaires were completed by patients participating in our study, including information about their age, gender, symptoms, medical and genetic history.

2.5 Identification of the Isolates

After receiving a positive signal from BacT/ALERT® 3-D device, subculture on an adequate amount of solid agar medium. Colonies that were grown on agar plates have been identified utilizing GN cards (ID) and GP cards (ID) of the VITEK 2 system (Biomerieux, France) after a period of overnight incubation. The ID findings from this conventional workflow served as a standard for comparison as the institution's protocol [9].

2.6 Antibiotics susceptibility test

A bacterial isolate's susceptibility to a set of antibiotics is ascertained through antibiotic susceptibility testing. Following being inoculated, the cards have been placed into the automatic reader-incubator of VITEK 2 system. For the purpose of ensuring that the quantity and density of microorganisms that have been inoculated onto VITEK2 cards have been appropriate, colony counts were employed [10].

2.7 Exclusion Criteria

We only excluded individuals with heart failure without a bacterial infection or sepsis.

2.8 Statistical Analyses

In SPSS version 22, the results were statistically examined to determine ANOVA (one away) and chi-square. Less than 0.05 is a significant probability level ($p < 0.05$).

3. Results & Discussion

3.1. Isolation of Bacteria

The statistical analysis results of Figure 1 had shown that there have not been any significant differences (p value= 0.5637) between the study groups, as the number of Gram negative bacteria =14 and Gram positive bacteria =11 in the group of healthy with bacterial infection, while the number of Gram negative bacteria =16 and Gram positive bacteria =9 in heart failure group with bacterial infection.

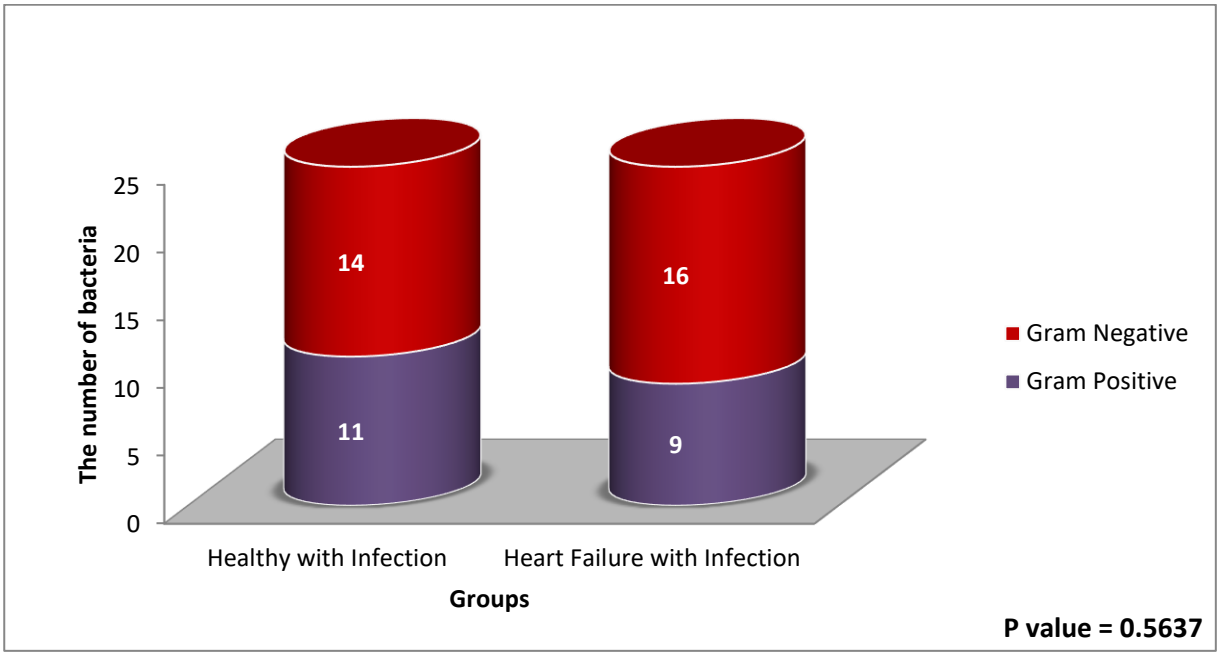

Figure 1 : The number of bacteria in groups with infection according to response of Gram stain

From observation of Table 1 results that the most common genius in healthy with infection group was *Klebsiella pneumoniae* which accounted for 8 (16%) isolates, followed by *Pseudomonas aeruginosa* and *Coagulase negative Staphylococci* isolates 4 (8%), 3 (6%) isolates of *Staphylococcus hominis*, 2 (4%) isolates of *Staphylococcus aureus*, 1 (2%) isolates for each of *Acinetobacter baumannii*, *Escherichia coli*, *Staphylococcus epidermidis* and *Staphylococcus haemolyticus* respectively. While, the most widespread genius in heart failure with infection group was *Staphylococcus hominis* which accounted for 5 (10%) isolates, followed by *Acinetobacter baumannii* and *Staphylococcus haemolyticus* isolates 4 (8%), 2 (4%) isolates for each of *Enterococcus faecalis*, *Coagulase negative Staphylococci*, *Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Staphylococcus aureus*, 1 (2%) isolates for each of *Escherichia coli* and *Staphylococcus psudintermedius*.

Table 1 : The type of bacteria in the study groups with infection.

Bacteria	Number of bacteria in group		Total(%)
	Healthy with infection	Heart failure with infection	
Acinetobacter baumannii	1 (2%)	4 (8%)	5 (10%)
Coagulase negative Staphylococci	4 (8%)	2 (4%)	6 (12%)
Enterococcus faecalis	0 (0 %)	2 (4%)	2 (4%)
Escherichia coli	1 (2%)	1 (2%)	2 (4%)
Klebsiella pneumoniae	8 (16%)	2 (4%)	10(20%)
Pseudomonas aeruginosa	4 (8%)	2 (4%)	6 (12%)
Staphylococcus psudintermedius	0 (0 %)	1 (2%)	1 (2%)
Staphylococcus epidermidis	1 (2%)	0 (0%)	1 (2%)
Staphylococcus aureus	2 (4%)	2 (4%)	4 (8%)
Staphylococcus haemolyticus	1 (2%)	4 (8%)	5 (10%)
Staphylococcus hominis	3 (6%)	5 (10%)	8 (16%)
Total (%)	**25 (50%)**	**25 (50%)**	**50 (100%)**

This result agree with previous study that reported were the most species of bacteria in patients with heart failure is *S. hominis* in significant differences from other kinds of species [11]. An earlier study had indicated that hospitalized heart failure patients had significantly higher incidence of bacterial infections, particularly with pathogens like *Klebsiella*, *Staphylococcus* and *Pseudomonas* species [12]. Another research that had been conducted on patients who have infective endocarditis that micro-biological findings included: *Streptococcus* sp., n (%) 12 (34.30%) *Streptococcus pyogenes*, n (%) 1 (2.90%) *S. agalactiae*, n (%) 1 (2.90%) Non-haemolytic *Streptococci*, n (%) 10 (28.60%) *Staphylococcus* sp., n (%) 9 (25.70%) *Staphylococcus aureus*, n (%) 2 (5.90%), negative coagulase *staphylococci,* n (%) 7 (20.00%) *Enterococcus* sp., n (%) 5 (14.30%) *Enterococcus faecalis*, n (%) 3 (8.60%) *E. faecium*, n (%) 1 (2.90%) [13]. Non-haemolytic *Streptococci* were a part of the following species: *S. mutans*, S*treptococcus* oralis, *S. homans*, *S. gallolyticus*, *S. agalactiae, S. parasanguinis,* and *S. bovis.* Negative coagulase *Staphylococci* were a part the following species: *S. hominis, S. epidermidis*, and *S. warneri* [13].

3.2. Antibiotics susceptibility Tests

3.2.1. Antibiotics Susceptibility for Heart Failure Group with Infection

From inspecting results of Table2 of the Antibiotics susceptibility profile for heart failure group with infection were found all species had be isolated were resistance to Ciprofloxacin 80%, Benzylpencillin and Oxacillin 56%, where's all species had be isolated were sensitive to the Pefloxacin, Colistin, Ampicillin, Ceftazidime, Ceftolozane, Vancomycin, Linezolid and Streptomycin.

Table 2 : Antibiotic Susceptibility profile for 25 isolates of bacteria by Vitek 2 system in heart failure group with infection (R-resistance, I-intermediate, S-sensitive).

Antibiotic	R	I	S	Resistance percentage%
Ticarcillin	4	0	21	16
Ticarcillin/ Clavlanic Acid	4	0	21	16
Piperacillin	4	0	21	16
Piperacillin/Tazobactam	6	0	19	24
Ceftazidime	8	0	17	32
Cefepime	8	0	17	32
Aztreonam	2	0	23	8
Imipenem	8	0	17	32
Meropenem	6	0	19	24
Amikacin	4	0	21	16
Gentamicin	10	0	15	40
Gentamicin High Level (synergy)	2	0	23	8
Tobramycin	4	0	21	16
Ciprofloxacin	20	0	5	80
Pefloxacin	0	0	25	0
Minocycline	2	0	23	8
Colistin	0	0	25	0
Rifampicin	6	0	19	24
Trimethoprim/Sulfamethoxazole	6	0	19	24
Ampicillin	0	0	25	0
Ampicillin /Sulbactam	2	0	23	8
Cefotaxime	2	0	23	8
Ceftazidime/Avibactam	0	0	25	0
Ceftolozane/Tazobactam	0	0	25	0
Tigecycline	2	0	23	8
Cefazolin	2	0	23	8
Levofloxacin	2	0	23	8

Tetracycline	10	0	15	40
Vancomycin	0	2	23	0
Teicoplanin	2	0	23	8
Linezolid	0	0	25	0
Erythromycin	12	0	13	48
Streptomycin	0	0	25	0
Streptomycin High Level (synergy)	2	0	23	8
Benzylpencillin	14	0	11	56
Oxacillin	14	0	11	56
Moxifloxacin	4	6	21	16
Clindamycin	6	0	19	32
Fusidic acid	12	0	13	48

3.2.2. Antibiotics Susceptibility for Healthy Group with Infection

From the examination of results of Table 3 of Antibiotic susceptibility profile for healthy group with infection were found all species had be isolated were resistance to Ciprofloxacin 80%, Gentamicin 76% and Ceftazidime 56%, where's all species had be isolated were sensitive to the Gentamicin High Level, Pefloxacin, Minocycline, Colistin, Ampicillin, Cefazolin, Levofloxacin, Vancomycin, Teicoplanin, Linezolid, Streptomycin and Streptomycin High Level.

Table 3 : Antibiotic Susceptibility profile for 25 isolates of bacteria by Vitek 2 system in healthy group with infection (R-resistance, I-intermediate, S-sensitive).

Antibiotic	R	I	S	Resistance percentage%
Ticarcillin	4	0	21	16
Ticarcillin/ Clavlanic Acid	4	0	21	16
Piperacillin	4	0	21	16
Piperacillin/Tazobactam	10	0	15	40
Ceftazidime	14	0	11	56
Cefepime	12	0	13	48
Aztreonam	4	0	21	16
Imipenem	12	0	13	48
Meropenem	12	0	13	48
Amikacin	6	2	17	24
Gentamicin	19	0	6	76
Gentamicin High Level (synergy)	0	0	25	0
Tobramycin	2	0	23	8

Ciprofloxacin	20	4	1	80
Pefloxacin	0	0	25	0
Minocycline	0	4	21	0
Colistin	0	0	25	0
Rifampicin	2	0	23	8
Trimethoprim/Sulfamethoxazole	12	0	13	48
Ampicillin	0	0	25	0
Ampicillin /Sulbactam	8	0	17	24
Cefotaxime	12	0	13	48
Ceftazidime/Avibactam	6	0	19	24
Ceftolozane/Tazobactam	6	0	19	24
Tigecycline	2	0	23	8
Cefazolin	0	0	25	0
Levofloxacin	0	0	25	0
Tetracycline	8	0	17	32
Vancomycin	0	0	25	0
Teicoplanin	0	0	25	0
Linezolid	0	0	25	0
Erythromycin	6	0	19	24
Streptomycin	0	0	25	0
Streptomycin High Level (synergy)	0	0	25	0
Benzylpencillin	10	0	15	40
Oxacillin	10	0	15	40
Moxifloxacin	2	4	19	8
Clindamycin	4	0	21	16
Fusidic acid	10	0	15	40

According to a prior study, multidrug-resistant pulmonary pathogens, specifically *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*, were substantially more common in older patients with cardiovascular disease, such as HF. These patients also had greater resistance to imipenem, ciprofloxacin, and ceftazidime [14]. According to another study, *S. hominis* was shown to be resistant to the following antibiotics: 92.2% oxacillin, 96.9% penicillin, 84.4% cefoxitin, 98.4% erythromycin, 79.7% levofloxacin, 85.9% clindamycin, 62.5% trimethoprim/sulfamethoxazole, 79.7% moxifloxacin, 9.4% gentamicin, and 9.4% rifampicin. However, there was 0% resistance to linezolid and vancomycin [15]. (100%) oxacillin, (100%) penicillin, (91.7%) cefoxitin, (91.7%) erythromycin, (100%) levofloxacin, (50%) clindamycin, (66.7%) trimethoprim/sulfamethoxazole, (100%) moxifloxacin, (75%) gentamicin, and (16.7%) rifampicin were all found to be resistant to *S.*

haemolyticus. *S. haemolyticus* revealed: Ten species that were resistant to benzyl penicillin, 3 species to oxacillin, 1 species to ciprofloxacin, 6 species to ampicillin, 2 species to cefoxitin, 2 species to gentamicin, 1 species to norfloxacin, 4 species to tetracycline, 1 species to erythromycin, and 1 species to tri-methoprim/sulfa-methoxazole, whereas there had not been any resistance to vancomycin or linezolid (0%) [15]. However, there is no resistance to chloramphenicol or doxycycline [16]. Piperacillin-tazobactam, Piperacillin, Ticarcillin-clavulanate, Cefotaxime, Imipenem, Ticarcillin, Ceftriaxone, Ceftazidime, Levofloxacin, Ciprofloxacin, Tobramycin, and Gentamicin were all shown to be ineffective against *Acinetobacter baumanii*. However, it demonstrated sensitivity to trimethoprim/sulfamethoxazole, amikacin, and doxycycline. According to [17], it is merely an intermediate to tetracycline. According to [18], *Acinetobacter baumanii* exhibited resistance to the following antibiotics: 5 of 6 (i.e., 83.30%), Sulbactam, 5 of 7 (i.e., 71.40%), Carbapenems, 6 of 9 (i.e., 66.70%), Quinolones, n 4 of 8 (i.e., 50.0%), Aminoglycosides, 4 of 11 (i.e., 36.40%), and Colistin, 0 of 7 (i.e., 0.0). According to a different Nepalese study by [19], *S. aureus* and CoNS are the most susceptible to vancomycin and amikacin. Additionally, *S. epidermidis* and *S. aureus* were shown to be highly resistant to Ciprofloxacin, Vancomycin, and Tetracycline amongst pathogens that have high rates of clinical detection in the [20]. Gram-positive as well as Gram-negative bacterial types were included in multidrug resistant (MDR) bacteria category. Because antibiotic overuse causes bacteria to develop resistance, the pattern of antibiotic sensitivity differs among studies and within the same institutions over time. Many antibiotic prescriptions have been made in clinical settings without first identifying the infectious germ or performing a test of antibiotic sensitivity, which is one of the many causes contributing to this major crisis. Furthermore, even after they start feeling better, patients usually do not take their medications exactly as directed, which increases the likelihood that the bacteria may become resistant to the drugs [21].

4. Conclusions

The study concluded that the most common types of bacteria were *Klebsiella pneumoniae* and *Staphylococcus hominis* in the group of patients with and without heart failure, and the isolated bacteria were highly resistant to some antibiotics and highly sensitive to others.

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دراسة البكتيريا المقاومة للمضادات الحياتية وتأثير الإنتان على مرضى قصور القلب في كربلاء

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[3] مستشفى مدينة الإمام الحسين الطبية في كربلاء، كربلاء، العراق

ملخص البحث

يمكن تعريف قصور القلب (HF) بأنه متلازمة سريرية معقدة، والتي قد تنتج عن أي اضطراب هيكلي أو وظيفي في القلب يؤثر على ملء البطين أو ضخ الدم إلى الدورة الدموية الجهازية. يمثل الإنتان عدوى قاتلة محتملة في الأعضاء تنتج عن استجابة غير منظمة للعضو المضيف للعدوى. كان العثور على أكثر أنواع البكتيريا انتشارا المسببة للإنتان في مرضى قصور القلب ومعرفة نمط حساسيتهم للمضادات الحيوية في مدينة كربلاء أهداف البحث المقدم. تم إجراء البحث في مركز القلب بمستشفى مدينة الإمام الحسين الطبية في كربلاء بين يناير وأغسطس من عام ٢٠٢٤. بعد دخولهم إلى وحدة العناية القلبية، تم سحب ١٠ ملليلتر من الدم الوريدي من ٢٥ مريض مصاب بقصور القلب والعدوى البكتيرية و ٢٥ مريض مصاب بعدوى الدم البكتيرية الذين لم يكن لديهم قصور القلب. تعد مزرعة الدم عملية حاسمة يجب أن نتبعها. بعد زراعة العينات في ظروف مختلفة للكشف عن البكتيريا، تم إجراء اختبار حساسية المضادات الحيوية. كان عدد البكتيريا سالبة الجرام = ١٤ والبكتيريا موجبة الجرام = ١١ في مجموعة المصابين بالعدوى بدون قصور القلب، بينما كان عدد البكتيريا سالبة الجرام = ١٦ والبكتيريا موجبة الجرام = ٩ في مجموعة قصور القلب المصابة بالعدوى وكان النوع الأكثر شيوعاً في مجموعة المصابين بالعدوى هو *Klebsiella pneumoniae* والتي شكلت ٨ (١٦٪) من العزلات بينما كان النوع الأكثر شيوعا في مجموعة قصور القلب المصابة هو *Staphylococcus hominis* والتي شكلت ٥ (١٠٪) من العزلات، وجد ان جميع الانواع المعزولة مقاومة لـ Ciprofloxacin بنسبة (٨٠٪) في كلا المجموعتين وكانت جميع الأنواع المعزولة حساسة لـ Pefloxacin ، Colistin ، Ampicillin ، Vancomycin ، Linezolid و Streptomycin.

الكلمات الرئيسية : الإنتان، قصور القلب، المضادات الحياتية، المقاومة، العدوى البكتيرية

